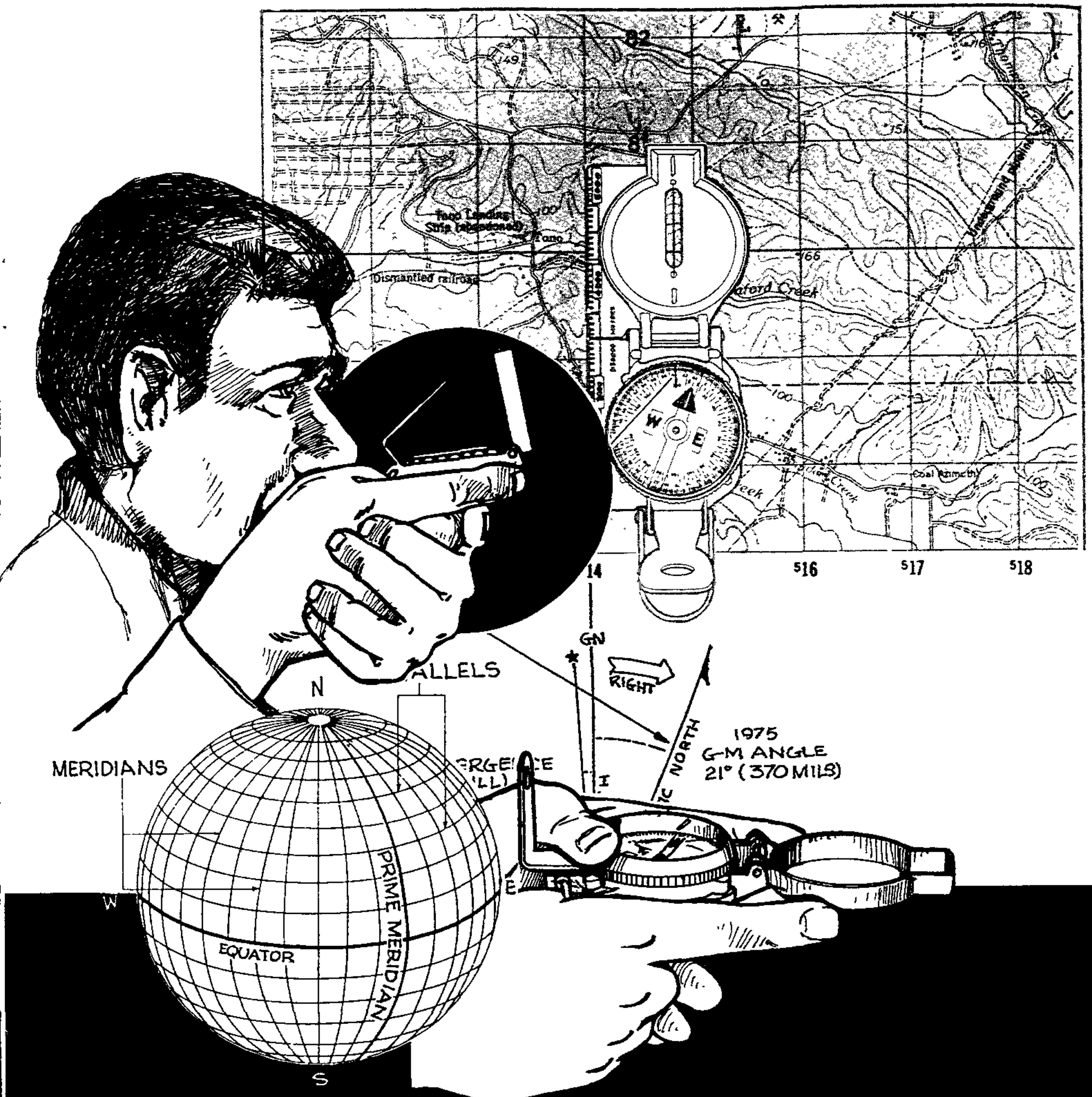

In Defense of the LENSATIC COMPASS

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As is the case with all kinds of equipment our armed forces use, there is often lively discussion about which type of magnetic compass best meets the needs of military land navigators. These arguments generally call for either the retention of the lensatic compass or the adoption of a protractor-type compass similar to those generally available to outdoor enthusiasts on the civilian market.

Before deciding which design is superior, we must carefully consider the rugged conditions under which direction finding equipment is used on the battlefield and the varied requirements it must meet. We must also thoroughly review the strengths and weaknesses associated with each of these two types of compasses. I believe that after such an examination, it will be obvious that the lensatic compass presently in service is the most useful and dependable for cross country movement.

The magnetic compass issued to military personnel to help guide their movements and determine their positions must perform a wide range of functions under less than ideal conditions. The following requirements must be considered when deciding which compass is best for Army land navigation:

Temperature Ranges. Soldiers may be called upon to operate and navigate during any season and in any geographic or climatic region of the world. Thus, a military compass must continue to operate accurately when exposed to a wide range of temperatures.

Compass makers learned long ago that placing a pivoted magnetic compass needle in liquid helped to stabilize it, thereby allowing quicker, more accurate directional readings to be taken. Thus, the term *damping* became associated with the magnetic compass.

The protractor-type compass still uses a clear liquid for damping, because the user can see through the instrument to view the orienting arrow and lines printed on the base. This transparent quality is necessary for taking directional readings in the field and when using the compass as a protractor on the map. The problem is that liquid-damped compasses, when compared with the more advanced copper induction damping system designed into the modern lensatic compass, have a severely limited range of operating temperatures.

STABILIZING

Manufacturers of the liquid-damped protractor compass say that the compass will stabilize within four seconds and will operate properly within a temperature range of -40 to +120 degrees Fahrenheit. On the other hand, the lensatic compass meets military specifications for stabilizing the compass needle in less than six seconds, and it will operate properly over a temperature range of -50 to +160 degrees. This range is 50 degrees greater than that of the protractor compass.

Before the copper induction damping system was developed, a leak in the liquid damping capsule was the most common cause of compass failure. Leaking seals on these capsules resulted either from rough handling or, more commonly, from being placed in temperatures either lower or higher than the designed limits during use, transport, or storage. Liquids expand rapidly, of course, at the freezing point and whenever heat is applied.

The manufacturer of one protractor-type compass includes the following cautions in its instruction manual:

Bubbles larger than 1/4-inch diameter should be viewed with suspicion and probably are caused by a leaking capsule ... Do not lay your compass near a radiator or where temperature can become extreme, such as on a pavement in the sun. The expanding liquid may damage the capsule.

Given the fact that military compasses are often carried and stored in dark-colored containers and placed in the sun, upper temperature limits of only 120 degrees will be difficult to avoid during the summer season in many parts of the world. It is unlikely that the soldiers who participated in Operation DESERT STORM could have protected protractor-type compasses from the excessive heat.

Accuracy. Accurate magnetic compass readings are often crucial for guiding military movements and generally are needed to determine positions precisely. Maintaining an accurate sense of direction and knowing where you are (position fixing) are essential to successful land navigation as well as to the effective employment of direct and indirect fire, tactical air support, and medical evacuation. They are also necessary for valid target acquisition; accurate reporting of nuclear, biological, and chemical (NBC) contamination and various danger areas; and obtaining emergency resupply. Few factors contribute as much to the survivability of troops and equipment and to the successful accomplishment of a mission as soldiers who know direction and their own location.

SIGHTING

Those who argue in favor of adopting a protractor-type compass will grant that sighting with a base-plate protractor compass is not as accurate as sighting with a lensatic compass. They do maintain, however, that it is accurate enough for field work.

There is no question that under ideal conditions when soldiers are moving easily and quickly from one area to another using terrain association backed up by rough compass checks, the degree of accuracy the base-plate protractor compass provides is satisfactory. But there are many times when their movements must be guided by a greater degree of accuracy — when visibility is greatly reduced by darkness, fog, smoke, or thick vegetation, for instance, or when they are operating in an area where there is little local terrain relief. Few would argue that precision in selecting good steering marks to guide movements by dead reckoning is especially difficult to achieve with a base-plate protractor compass. At these times, soldiers must have the accuracy a lensatic compass provides.

Another time when soldiers will require more accuracy is when they must determine their position by resection and intersection using terrain features at great distances. In such places as the National Training Center (NTC), for example, it is not uncommon for a unit to use terrain features 10 kilometers or more from its location to determine a position or to guide its movement. At these times, accurate compass readings can be a matter of survival and can make the difference between mission success and failure.

The amount of error introduced for every degree of inaccuracy read from a compass is equal to 18 meters per kilometer. Therefore, over a distance of 10 kilometers, an inaccuracy of six degrees results in well over one kilometer of error (18 x 6 x 10 = 1080 meters). This is not acceptable for units that expect to train successfully or to win in combat.

The more expensive protractor compasses do offer a built-in mirror-type sighting system that allows a user to sight on distant objects. Unfortunately, though, this feature introduces two additional problems:

ORIENTING

Alignment and Leveling. First, when the directional azimuth being measured is close to either north (0 degrees) or south (180 degrees), the north pointing arrow and the orienting arrow on the base are easy to align. But when the azimuth being measured approaches either east (90 degrees) or west (270 degrees), a correct alignment of the north pointing arrow and an accurate directional reading are much more difficult to achieve. When facing an azimuth of either 90 degrees or 270 degrees, I have measured as much as a six-degree error when I incorrectly aligned the tip of the north seeking arrow with the point of the orienting arrow on the base instead of allowing for the parallax problem encountered under these circumstances.

As if to prove this point, most protractor-type compass manufacturers also offer hand-bearing compasses designed much like the lensatic compass on which the magnetic north arrow is attached to and rotates with the circular directional scale. Most of these compasses also use a sight and lens with which to take accurate directional readings.

The second problem introduced by this mirror-type sighting feature is the difficulty it causes in trying to hold the compass level.

All compasses must be held in a level position to take accurate directional readings. Otherwise, the north seeking needle or rotating directional card will rub on the bottom of the instrument, causing it to give an inaccurate reading.

The difficulty encountered in trying to hold a protractor compass with a mirror-type sighting feature level is that the user can see only the tilted image of the compass. When he sights on a distant feature, he must line up the magnetic north arrow with the orienting arrow as he looks into a tilted mirror reflecting the tilted image of the compass face while, at all times, attempting to keep the instrument level. This can be quite a challenge.

There is yet another problem with using the mirror sight on a protractor compass. Compared with the vertical sighting slot and wire on the lensatic compass, the mirror sight is difficult to use when the feature being viewed has a significantly higher or lower elevation than the position on which the user is located. This circumstance greatly compounds the challenge of keeping the compass level.

Map Protractor Readings. In addition to the limitation associated with the protractor compass's liquid damping feature, the next most serious disadvantage with it, ironically, is its alternate use as a map protractor. While it is true that the design of the protractor compass does make it the easier one to use as a substitute for the map protractor, this design also presents some serious shortcomings.

More specifically, some people mistakenly believe they can plot magnetic compass azimuth values directly on the map simply by taking a directional reading with a protractor compass in the field and then, without further adjustment, laying the compass directly on the map to make a directional plot. This is just not the case.

The fact is that when using the protractor compass as a map protractor, a soldier must first convert the directional reading taken in the field, using the grid-magnetic (G-M) angle found on the map's margin, before plotting it on the map as a grid azimuth. This means the soldier must be taught to slip the compass scale the appropriate number of degrees in the correct direction *after* using it to determine a real world direction yet *before* using it as a map protractor. Of course, he must take the opposite action for any directional value he reads off the map using the compass as a protractor before applying it on the compass in the real world. This confusing "scale slip" procedure is thoroughly described in most instructional sheets accompanying protractor-type compasses.

MARKING

There are only two conditions under which the protractor compass can be used on the map without concern for the conversion between grid and magnetic azimuth values. These conditions are:

- When the map being used is specially prepared with "magnetic north meridian lines" drawn on it (explained in some protractor compass instruction sheets).
- When the protractor-type compass being used has a special declination correction feature built into it.

There is no question that it is far easier to use a separate map protractor than to add these extra lines to all the maps. Whenever this alteration is accomplished, it must be done *precisely* by a knowledgeable person using drafting tools. But I do not recommend that it be done at all; our large-scale Defense Mapping Agency (DMA) maps already contain a wealth of detail that a navigator must be able to see and use easily. Any additional clutter may reduce the readability of a map. In fact, it is always best to refrain from making any extraneous markings on our maps. Even necessary tactical and operational details should be kept to a minimum and placed on overlays or on the map case or cover.

When making directional plots on a map with a protractor-type compass, a user must first correctly orient the compass on the map. He does this by rotating the entire instrument until the *orienting arrow* and the *orienting lines* are perfectly aligned with the grid pointing north. The problem is that when a protractor compass has a built-in declination adjustment feature, any adjustment being applied causes the orienting arrow and the orienting lines to point in different directions. This can easily lead to confusion as to which of the two is to point directly north on the map when the compass is correctly oriented. This confusion can then result in significant errors when a soldier is plotting a position using resection or intersection or when using an azimuth to guide his movement. Hopefully, he will not be calling for close-in fire, looking for an emergency evacuation, or searching about for a coordination point at the same time he is making these unnecessary mistakes.

It may be best — no matter which type of compass a soldier is using — always to use a compass for finding directions in the real world and a separate protractor for that same purpose on the map. Anyone who is concerned about breaking or tearing his protractor should know that there are unbreakable models on the market. A special adjustable protractor is also available that allows a user to plot and read magnetic azimuths directly on the map without first having to convert between grid and magnetic values.

Night Use. Because much present and future combat is likely to occur at night, a military compass must be easy to use during the hours of darkness. The lensatic compasses now being procured contain vials of tritium gas, which provides a subdued green fluorescence that allows them to be read easily at night without any external light source. This constant source of illumination, coupled with the bezel ring and clicking feature, make the lensatic compass the best possible guide for a night fighter.

The luminous features found on some protractor-type compass models require frequent charges from a light source, cannot be reset for another direction, and do not allow azimuth readings to be taken unless the compass is illuminated by another light source. The azimuth directional scale on a protractor-type compass is printed on the outside edge of the compass housing, which is normally black. And, of course, using a flashlight frequently at night during combat operations is not a good idea.

Some who favor the adoption of the protractor-type compass argue that the major problems with training soldiers in land navigation skills today are directly associated with teaching them how to read a compass and use a map protractor. In addition, they often state or imply that the lensatic compass is difficult to learn to read. These arguments and implications are simply not true.

From 1982 to 1990, the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) conducted extensive research to identify and improve both the execution and the training of all critical land navigation skills. Teaching soldiers to read a lensatic compass was *not* found to be a weakness. The use of the lensatic compass in the center-hold position to determine rough compass direction is as easy as using the base-plate protractor-type compass. The compass-to-cheek method for more precision does require a bit more training, but soldiers seem to master this skill quickly and without difficulty.

Problems do result, however, when trainers and soldiers equate an ability to navigate over distances with finding their way around a short compass course consisting of stakes only 25 or 50 meters apart. The research indicated that we fail to teach our soldiers to use terrain association techniques adequately when moving cross-country. Even on a compass course, for example, it would be helpful to look closely at the map to determine whether the correct stake is located on a small spur or in a draw.

In summary, the research showed that the source of our current execution and training problems is our failure to prepare our soldiers thoroughly and to require them to use more advanced navigation skills — it is not their inability to use a map protractor or lensatic compass. These advanced skills include terrain analysis, map interpretation, good position fixing techniques, movement by terrain association, smart dead reckoning (with a terrain association backup), navigation in special circumstances (mounted and in different geographic and climatic regions), and using the various types of maps and aerial photographs that may be the only ones available for a given area of the world.

Finally, it is frequently argued that we are using an old outdated compass. Some people believe that because the protractor-type compass is new and modern it is therefore better. In fact, the base-plate protractor-type compass, developed in Sweden in 1928, has been around for some time, while the modern copper-induction-damped lensatic compass with illumination by tritium gas is certainly a recent development. If the basic design of the lensatic compass is superior to another compass, the Army should continue using it until something better (not just newer) comes along.

ARI researchers in the field did find several old, unserviceable lensatic compasses still being used by some of our schools and units. As with any other piece of equipment, commanders and trainers should ensure that all compasses are completely functional and should turn in those that need replacement. But this is not a selection problem; it is a replacement problem.

The lensatic compass presently in service is the one that best meets the needs of military land navigators. It is capable of performing a wide range of functions on the battlefield under less than ideal conditions — when it counts most.

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